COMPUTERS AND INFORMATICS
2757-8259 2023, Volume 3 Issue 2
Research Article

A Web-based training method of agricultural skills for temporary workers

Dai Kusui *
NEC Solution Innovators, Ltd., Tokyo, Japan, kusui@nec.com
Hideo Shimazu
NEC Solution Innovators, Ltd., Tokyo, Japan, shimazu.hideo@nec.com
Atsushi Shinjo
Keio University, Tokyo, Japan, kaminari@sfc.keio.ac.jp

Submitted: 17.03.2023
Accepted: 31.08.2023
Published: 31.12.2023

* *Corresponding Author*

Abstract:

We propose a Rapid Agri-InfoScience (RAIS) learning model that has been adapted to the situation of teaching temporary workers. This learning model is a model by which workers can learn how to make the decisions necessary to execute tasks by narrowing down the number of tasks and further limiting the target area to a single crop at a particular time and place. By restricting the number of factors needed to judge and work the crop at one location at a particular time, instructors can create exercises that are suitable for the situation at that time. Because the system implemented the model creates exercises based on images, the exercises can easily be adapted to different languages. This feature will lead to the realization of computer-aided instruction (CAI) that eliminates the language barrier and makes it easier to accept foreign human resources. The system is characterized by not only enabling temporary workers to learn on the farm but also enabling instructors to create exercises on the farm when necessary. Using this system, experiments confirmed that instructors can create the exercises by which temporary workers can improve the quality of their work, as confirmed by instructors visually evaluating the quality of the work.

Keywords: *Agricultural work skills, E-learning, Temporary worker, Training method, Web-based learning*

Cite this paper as: Kusui, D., Shimazu, H., & Shinjo, A., A Web-based training method of agricultural skills for temporary workers, *Computers and Informatics*, 2023, *3*(2), 93-105.

1. INTRODUCTION

Agriculture has off-seasons and busy seasons, and not all farmers need the same number of workers throughout the year. It is difficult from a cost standpoint to maintain the same level of employment throughout the year, so farmers usually bring in temporary workers to help only during the busy season. Temporary workers, however, are not engaged in farming all year round, and it is not always possible for farms to hire the same people every year. It is uncertain whether the person hired this year has the knowledge and experience to do the work in question. In addition, the weather conditions and the conditions of the field and crops differ year by year, and the work needs to be adapted to the current conditions. To ensure that the work is done smoothly and at a consistent level within a limited amount of time, it is desirable to provide guidance to the temporary workers on a case-by-case basis.

Temporary workers' jobs do not require highly specialized knowledge, but they need to learn quickly in a very short period. It is common for temporary workers to have only a few days of work and to start their tasks at the farm on the day they arrive. In cases where temporary workers need to complete their work in just one day, their education, including the creation of materials, needs to be completed in as little as 1-2 hours. To carry out the work smoothly and at a consistent level within a limited time, it is necessary to guide temporary workers effectively and efficiently. However, with existing e-learning systems, it was necessary to first perform an overall design of knowledge, such as analyzing the entire flow, and to spend time and effort on data collection and preparation, as well as the support of experts to complete the content. The use of the system to create problems on-site as needed was not envisioned.

For transferring agricultural skills, the conventional Agri-InfoScience learning model is proposed. This model has been used in many places with some success [1]. It, however, is not necessarily suited for teaching temporary workers how to do tasks in a short period of time in accordance with each situation.

In this paper, we propose a Rapid Agri-InfoScience (RAIS) learning model that has been adapted to the situation of teaching temporary agricultural workers. This learning model is a model by which workers can learn how to make the decisions necessary to execute tasks by narrowing down the number of tasks and further limiting the target area to a single crop at a particular time and place. By restricting the number of factors needed to judge and work the crop at one location at a particular time, instructors can create exercises that are suitable for the situation at that time.

Our proposed model was implemented in a Rapid Agri-InfoScience (RAIS) learning support system as a web-based training system (WBT). A WBT is a type of e-learning and computer-assisted instruction (CAI). It is a distance learning system that enables learning anywhere by using a web browser or the Internet. WBTs are used in various fields and are expected to play an important role in the agricultural sector in Japan in the future [2]. Because the RAIS system uses image-based exercises, the exercises are easily adapted to different languages. This feature will lead to the realization of CAI that eliminates the language barrier and makes it easier to accept foreign workers.

The RAIS system enables not only the temporary workers to learn on the farm but also enables instructors to create exercises on the farm at the precise time they are needed. By using the learning support system in which the RAIS model was implemented, experiments confirmed that the instructors can create the needed exercises and temporary workers can improve the quality of their work, as determined by instructors conducting visual evaluations of the work. Before learning, the quality level of the temporary workers' work was below the basic level. After using the RAIS system, the quality level of the temporary workers' work was rated 60% higher than the basic level.

2. RELATED RESEARCHES

According to the 2020 Census of Agriculture and Forestry (a statistical survey conducted every five years by the Ministry of Agriculture, Forestry, and Fisheries of Japan) [3], the average age of key agricultural workers in private farming enterprises is 67.8 years old with 69.6% of these workers aged 65 or older, indicating an aging industry. In Japan, numerous crops are grown in each production area in accordance with the climatic environment that varies greatly from region to region, and a wide variety of agricultural knowledge, technology, and know-how have been accumulated in each production area for the specific crops. The creation of a mechanism for passing on these skills is needed to preserve this knowledge, technology, and know-how for the future. Skilled farmers have tacit knowledge based on intuition and years of experience—so-called artisan skills—and that knowledge cannot be easily learned by others. It is necessary to convert those skills into digital data in a form that can be learned. Agri-InfoScience advocated by Shinjo [1] is an approach to this.

Agriculture can be defined as a system involving the information held by the environment, plants and farmers. Environmental information includes the temperature, humidity, amount of sunlight, and other factors. Plant information includes varieties, growth days, nutritional values such as acidity and sugar content, fruit size, and stem diameter. As shown in Figure. 1, agriculture can be viewed as a system that consists of environment, plants, and farmers. In this system, information on the environment and the plants is communicated to farmers, farmers perform operations based on that information to promote the growth of plants, and these operations have an impact on the environment and the plants. Agriculture can be considered as a system in which farmers perform work for the purpose of promoting plant growth based on transmitted information and that work affects the environment and plants [4][5]. To improve the efficiency of this system, it is necessary to correctly understand the information from the plants and to correctly select and perform agricultural operations based on the information obtained. Agricultural knowledge, technology, and know-how are necessary for proper execution.

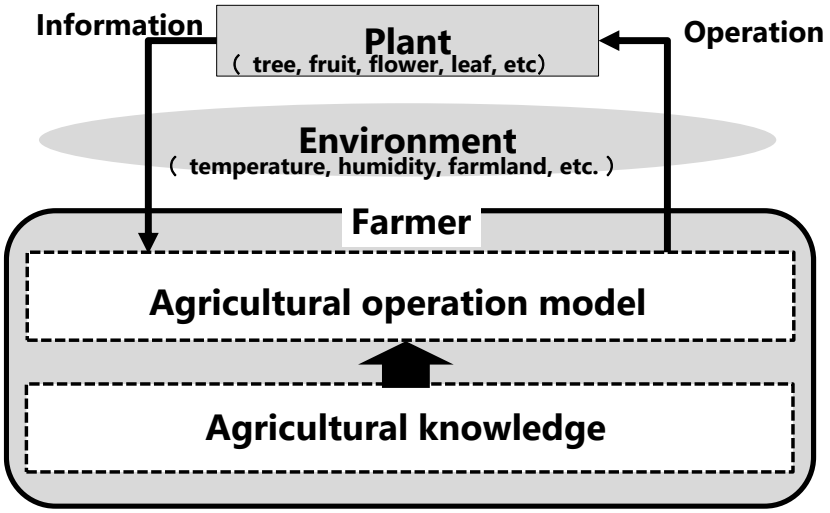

Figure 1. Model of agriculture as a system

For example, Shinjo and Kudo [6] categorized three types of skills based on the conceptualization by Matsumoto [7], Nakayama [8], and Arai and Shirakawa [9]. For knowledge in agricultural work, the three types of skills are motor skills (skills to operate machinery), sensory skills (skills to understand the situation), and intellectual management skills (skills to plan arrangements).

Plant conditions and environments are constantly changing. The appropriate farming operation depends on the plant conditions and environments. Farmers understand the condition of crops and the environment, make appropriate decisions based on that knowledge, and work based on those decisions. Each farmer's productivity and crop quality are highly dependent on their work. In the conventional Agri-

InfoScience learning model, skills and knowledge related to farm work are divided into three steps as shown in Figure. 2 [10]. Situational awareness is the ability to look at the farm and crops and be able to notice slight changes. Judgment is to decide how to respond to the changes noticed by the situational awareness. Work is to affect the farm or crop as a response to the changes. The quality of farm work as well as the quality and yield of the crops can become better by improving each of these three steps.

- *Observation knowledge: Knowledge of what to pay attention to in order to understand the situation.*
- *Decision knowledge: Knowledge of how to make decisions based on the information obtained by paying attention to the situation.*
- *Action knowledge: Knowledge of how to move the body based on decisions made.*

In agricultural work, the conditions of the crop and the environment surrounding the crop are constantly changing, so it is important to make decisions in accordance with these conditions. However, it is very difficult to enumerate all situations and to express knowledge of what decisions should be made under what circumstances. For example, it is said that it takes 10 years to master the experience and intuition of a skilled farmer, as expressed in the Japanese phrase "10 years of watering." Too much watering can cause root rot and overgrowth of fruit, and this can lead to cracking. Too little water and the plants weaken and die. The proper amount of water at the right time—including crop and soil conditions and possibly even weather—makes is possible to grow crops that are both tasty and of the right size.

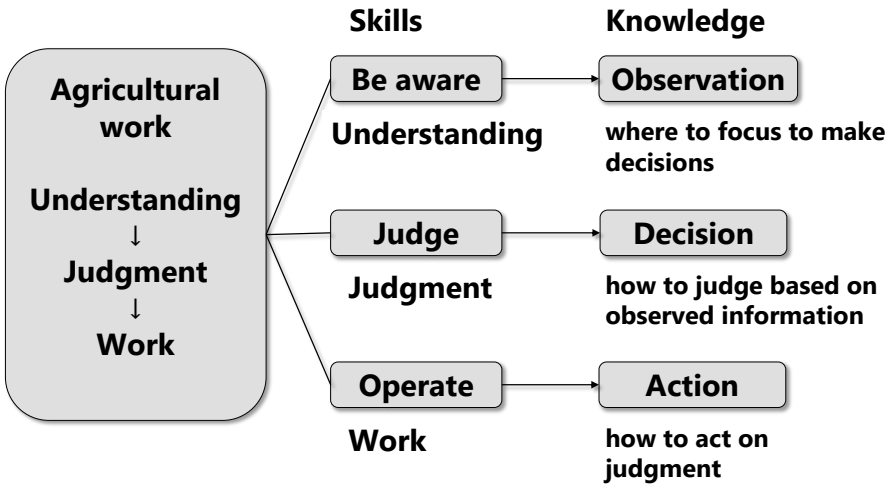

Figure 2. Skills and knowledge model

3. APPLICATION OF AI AGRICULTURAL LEARNING MODELS TO TEMPORARY WORKERS

The aim of the conventional Agri-InfoScience learning model is for farmers to learn the basics and become skilled farmers who can envision the broader view. On the other hand, some areas had an aim that was different from the conventional learning model. Actual farming, in addition to decision makers, involves many temporary workers. Farmers make decisions about what to do and how to do it with respect to crops and the environment. The temporary workers do not make the various decisions but ensure that the tasks assigned to them are carried out in response to the decisions made by the agricultural producers. The workers are therefore required to learn how to make the judgments necessary to execute the tasks in a short period of time. The creation of a learning mechanism for temporary workers is needed in keeping with the conventional Agri-InfoScience learning model.

4. EXAMPLE OF TRAINING TEMPORARY WORKERS IN HARVESTING MANDARIN ORANGES

We consider the harvesting of mandarin oranges as an example of work performed by temporary workers. Harvesting is a common agricultural task that is not limited to a specific region or crop. Mandarin oranges are cultivated mainly in coastal areas west of the Kanto region of Japan. The main types of fruit grown in Japan in 2020 were mandarin oranges, apples, persimmons, chestnuts, and grapes, in that order. Harvesting mandarin oranges seems to be a simple task that does not require any instruction, but the farmer provides temporary workers with instruction in harvesting. The method and content of instruction might vary from farmer to farmer or might change depending on the weather conditions or the crop status of that year. In the Yame region of Fukuoka Prefecture where the demonstration experiment described in this paper was conducted, we interviewed agricultural producers (instructors) and found that they instructed their temporary workers as follows.

(1) Prior learning (acquisition of basic skills)

> *The instructor first taught the basics to the temporary workers. Basic instruction included, for example, picking the fruit without tearing, placing the fruit gently in the basket instead of throwing it, and cutting the stem twice. Cutting the stem twice means that the first cut should be made in an easy-to-cut area when harvesting, and the stem should be cut shorter a second time so that the fruit do not damage each other when placed in a basket or box.*

(2) On-the-job training (updating skills)

> *After teaching the basics, the instructor stayed with the temporary workers until they were able to properly do the work. It was not easy for the instructor to teach everything at the beginning, and workers needed to learn much more than the basics. When the temporary workers were doing their assigned tasks, the instructor pointed out things that they should notice. For example, the instructor taught how to identify the colors and shapes of the fruit to be harvested, how to cut the fruit's stem twice so as not to damage it, how to use harvesting scissors, and how to avoid cutting the leaves when cutting the fruit.*

When several temporary workers were hired, the instructor needed to check each individual's level of understanding, even though they were taught in the same way. The instructor was limited in how many workers could be supervised at one time, and this was very time-consuming and labor-intensive. In some cases, multiple temporary workers were hired for several days at a time, and if a new worker was hired each day, the exercises had to be taught again to the new workers separately from the rest.

5. A RAPID AGRI-INFOSCIENCE LEARNING MODEL

In this paper, we propose a Rapid Agri-InfoScience (RAIS) learning model. This is a new learning model that follows the conventional Agri-InfoScience learning model but aims to reduce the time and effort required for the instructor to teach exercises and to enable inexperienced temporary workers to respond appropriately to a given task in a short period of time. In the conventional model, the learner repeatedly learned how to respond to various situations to ensure the acquisition of skills. Learners were given a variety of situational exercises, and they repeatedly answered them and then saw the correct answers and explanations. However, it was not easy for the instructor alone to organize responses to various situations, and the creation of exercises required the assistance of an expert. It was therefore necessary to prepare all exercises in advance.

In contrast to the conventional Agri-InfoScience learning model, the RAIS model is a model that limits the tasks and furthermore, it limits the target only to the crop being handled at that moment and workers learn how to make judgments necessary for executing the tasks. Specifically, because the target is limited

to judgments made about a crop in a particular time and place, instructors must create the necessary exercises then and there. In other words, it is reasonable to expect instructors to create exercises by themselves then and there. If so, instructors who can teach then and there should be able to also create exercises relevant to the situation at that time and place, and the temporary workers should be able to learn those exercises through repetition.

Because instructors create exercises then and there, exercises do not have to be prepared in advance, and immediate action is possible even if the environment or crop conditions require additional instruction to the workers or if the created exercises are inadequate. This greatly reduces the psychological hurdle for the instructor in creating exercises. Temporary workers repeat exercises that the instructor has created with a focus on how to judge the crops then and there and they will be able to respond appropriately to the given tasks in a short time. Instructors can hire many workers for a single job to quickly complete the work. The RAIS model is a compact learning model for learning knowledge about the agricultural tasks as shown in Figure. 2. As shown in Figure. 3, the model is limited to the crop at one specific time in terms of situational awareness. By limiting the situation to the crops at that time and place, the instructor can create exercises then and there. The learning range can be greatly limited, and temporary workers can learn efficiently with a small number of exercises.

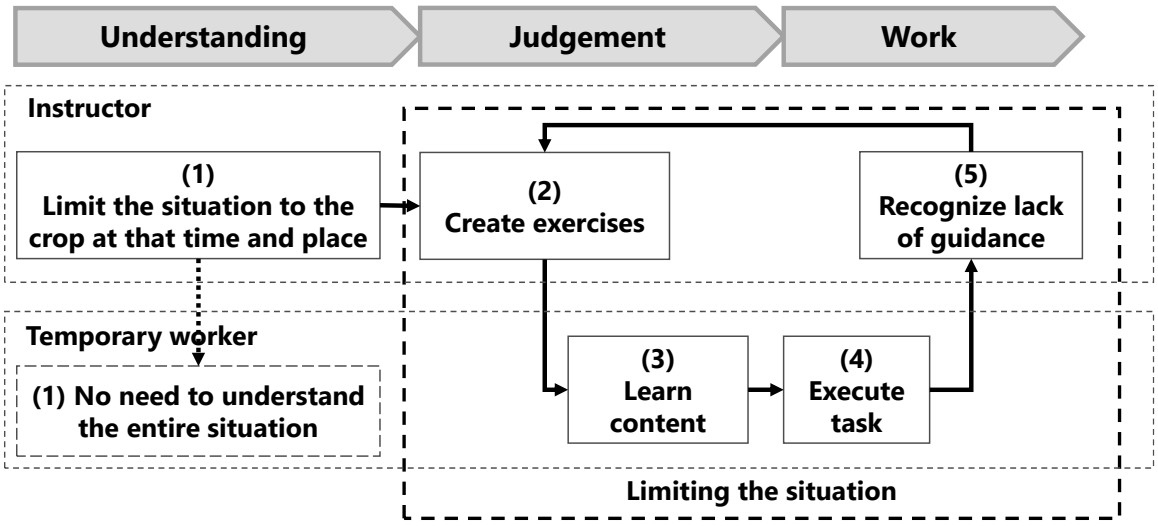

Figure 3. A Rapid Agri-InfoScience learning model

6. A RAPID AGRI-INFOSCIENCE LEARNING SUPPORT SYSTEM

We have developed the Rapid Agri-InfoScience (RAIS) learning support system, which is suitable for the RAIS model. This RAIS system focuses on learning how to judge the crops at a particular time and place, so the exercises have many similarities. Specifically, the exercises have similar patterns, such as the same wording for the question and explanation but different images or the same wording for the question but different images and explanations. For this reason, this system has a function that can be used to create a library of previously registered exercises as patterns and then register them as new exercises after modifying some of the images, explanations, and questions. Figure. 4 shows a screenshot of the library function. A list of previously registered exercises is displayed, and exercises can be narrowed down by crop, task, and keywords included in the question and explanation. The View button can be pressed to display the contents of the exercises, and then the exercises can be modified or deleted. A modified exercise can be registered as a revised exercise (using the Overwrite button) or registered as a new exercise (Register new).

In addition, the RAIS system has the following functions:

- *Exercises can be aggregated on a cloud server, enabling learning without time or location constraints.*
- *The system can record and analyze the learning history to confirm which exercises have been learned and how much knowledge has been acquired after using the RAIS system.*

For the first function mentioned, when the exercises are aggregated on the cloud server, the instructor can update the exercises and the workers can learn the latest exercises as usual without having to do any additional steps. Because the RAIS system can be used in a web browser, workers can learn the exercises provided by the system at any time and place, by using their smartphones or tablets. For example, when the instructor adds an exercise, a worker can do the exercise even if the instructor is not nearby.

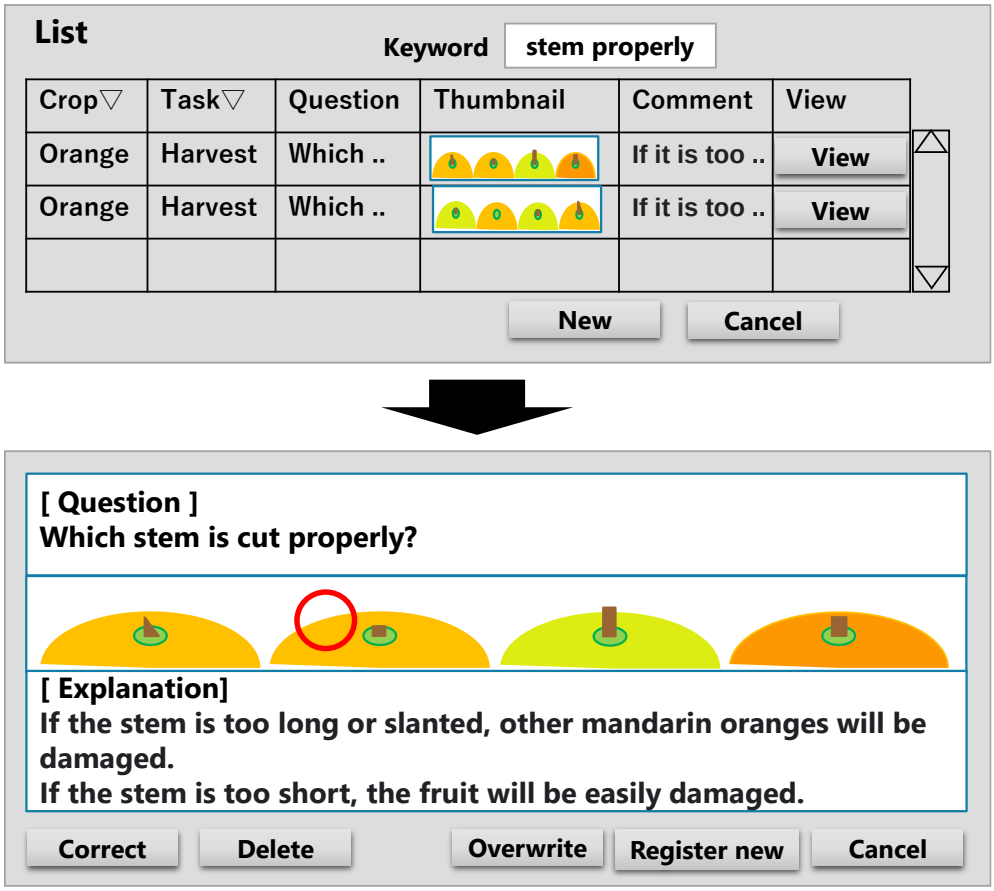

Figure 4. Screenshot of the library function

Regarding the second function, in the RAIS system, the instructor has the authority of a teacher, and the temporary workers have the authority of students. The teacher has all the same privileges as a student but can also create exercises and view the results of all students. Student privileges enable students to answer exercises and view their own results. The system has the following three analysis functions.

- *Learning history*
- *Learning ranking*
- *Proficiency management*

The learning history is a list of the temporary workers who answered which exercises, when, and how many times as well as whether or not the answers were correct or incorrect. The list can be narrowed down by filters that set the conditions of a search, and the instructor can download the results from a

narrowed search or all of the data. The learning ranking is a ranking of the workers based on the number of answers and the correct answer rate for each type of crop and task. Proficiency management can be used to view a list of the number of questions answered by each worker and their accuracy rate. It is possible to check how much knowledge each temporary worker has acquired.

7. LEARNING PROCESS

In the Rapid Agri-InfoScience (RAIS) learning model, the instructor can create exercises then and there about how to judge a crop at that particular time and place. Temporary workers study those exercises through repetition. The instructor can quickly and easily create exercises with similar patterns by using the RAIS system's library. In addition, because exercises with a low accuracy rate are likely to be difficult for temporary workers, instructors can refer to the learning history and add similar exercises then and there. The learning process is as shown in Figure. 3. Figure. 5 also shows an image of the learning process.

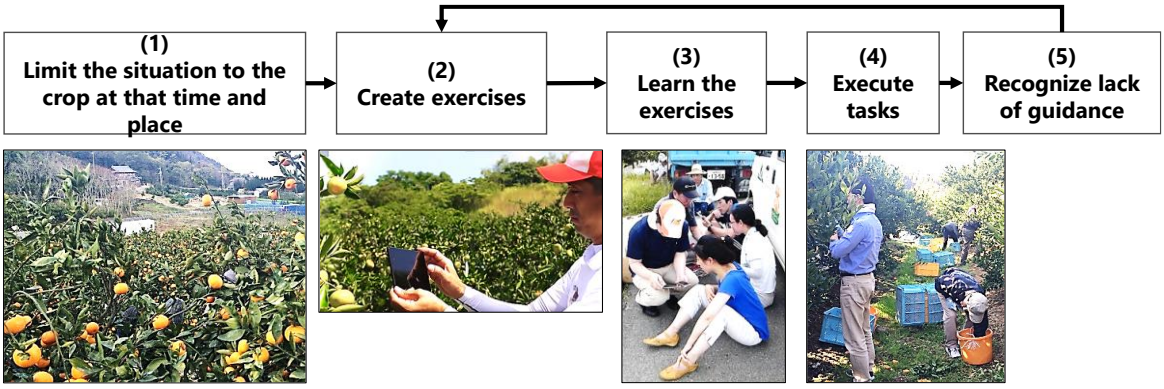

Figure 5. Learning Process Image

(1) Limit the situation to the crop at that time and place

> *The instructor specifies the work to be performed by the temporary workers on the crop at that time and place.*

(2) Create exercises

> *The instructor creates the exercises. The instructor extracts what kind of judgment is needed to do the task. The instructor prepares images, questions, and explanations. Both correct and incorrect examples are prepared as images, and the exercises are registered with the RAIS system. The instructor can retrieve exercises that have already been registered from the library, modify any exercises, and register them as new exercises by using the library function of the system.*

(3) Learn the exercises

> *Temporary workers repeatedly study the exercises created by the instructor. They answer the exercises presented by the system and check the answers and explanations.*

(4) Execute tasks

> *The workers perform the task after the exercises have been learned.*

(5) Recognize lack of guidance

> *The instructor periodically observes and checks the work of the workers. The instructor also checks their learning results by using the learning history of the RAIS system. When the instructor notices that the*

quality of work is low for one or more individuals, the exercises have omissions that should be taught, or a pattern in the exercises with a low accuracy rate when checking the learning history, the instructor can use the library function of the RAIS system to add exercises for those specific cases. The workers can use smartphones or other devices to access their individual learning histories. The workers learn the added exercises from their smart devices by using the learning support system and improve their abilities to respond to those situations.

8. EXAMPLE OF CREATING EXERCISES IN A MANDARIN ORANGE HARVESTING OPERATION

Using mandarin orange harvesting as an example, the following is a concrete example of how exercises can be created in a demonstration experiment, based on (1) limiting the situation to the crop at the time and place and (2) the creation of exercises in the aforementioned learning process.

(1) Limit the situation to the crop at the time and place

The decisions made when farming is limited by the crop in the field at that particular time and by the farmer's thoughts about the crop. For example, if the instructor sees the growth of the crop and decides to harvest a crop of fruit that is at least 5 cm in diameter and at least seventy-percent colored because the first crop can receive a high price, the temporary workers need to be able to judge the size and color. If the season is nearing its end and the decision is made to harvest all remaining fruit, the temporary workers do not need to be able to judge size and color.

In the mandarin orange harvest, the length of the stem is adjusted by cutting the fruit twice, because leaving the stem too long or too short can damage the fruit. Temporary workers must be able to judge the proper stem length. The workers must also be able to remember what not to do when harvesting mandarin oranges, such as not tearing off the fruit or throwing them into the basket.

Some decisions do not need to be learned by the temporary worker depending on the situation, while other decisions need to be learned regardless of the situation. In the case described in this paper, it is assumed that all remaining fruit must be harvested. If so, the temporary workers need to be taught how to make the decisions necessary to cut the fruit's stem twice as well as the precautions to take during the operation. Exercises can be created by two methods.

(2) Creating exercises

For example, in the first method, the instructor creates an exercise about adjusting the length of the stem by cutting twice. In the exercise, some fruits are arranged: one with the appropriate remaining stem, one with a stem that is too long, one with a stem that is too short, and so on. The workers are asked to select the appropriate fruit. The exercise consists of an image, a question, an explanation, and the answer (correctly marked picture). The picture is a photograph in which several fruits are arranged. "Which stem is cut properly?" is the question. "If the stem is too long or slanted, other mandarin oranges will be damaged. If the stem is too short, the fruit will be easily damaged." is the explanation. The fruit in the picture with the stem properly cut is circled as the correct answer. The instructor registers the exercise in the RAIS system.

Exercises are registered in a library. In the second method, when an exercise with the same pattern is to be registered, the registered exercise is retrieved from the library and modified. The retrieved exercises can be modified by using different photos or specifying the correct answers in the photos. The modified exercises are then registered as new exercises, leaving the text for the question and explanation as is. In this way, exercises using the same pattern as shown in Figure. 6 can be easily created.

Another style for an exercise might be, for example, the instructor prepares an image of a person pulling an orange off a branch instead of cutting the stem and an image of a person throwing mandarin oranges in a basket from a high location without crouching down near the basket and then creates a question asking what is being done incorrectly. Or an example of the correct method and an example of the incorrect method with explanations that explain the differences could be prepared.

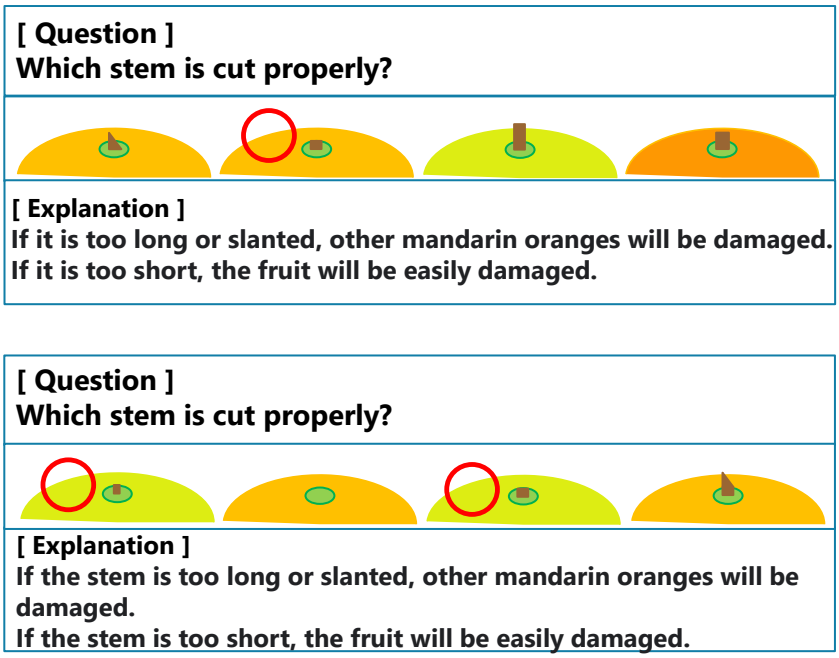

Figure. 6. Example of the exercises

9. EXPERIMENT AND EVALUATION

A) Purpose of Experiment

In the experiment, we targeted the harvesting of mandarin oranges. Using the Rapid Agri-InfoScience (RAIS) learning support system, we wanted to verify A) if the instructors could create the required exercises in a short amount of time before the task was to be done and B) if the exercises could improve the quality of the temporary workers' work. In addition, by means of a questionnaire to the instructors after the evaluation, we wanted to verify C) if the instructors noticed anything they wanted to add to the exercises while the workers executed their tasks and if the instructors could create the additional exercises to provide that missing information.

B) Instructors' creation of exercises in a short period of time

The target of this experiment was to create exercises for harvesting all the remaining mandarin oranges in a harvesting operation. This meant that the temporary workers needed to learn two points: how to cut the stems twice and the precautions to be taken while working.

Using this system, we asked the instructors to create exercises using two methods before starting work. The instructors created and registered exercises similar to those shown in Figure. 6, and then the instructors created and registered more exercises using the library function of the system. As a result, a single instructor was able to create a total of 24 exercises in approximately 60 minutes before the work started. These 24 exercises included 20 exercises on the decision to cut stems twice and 4 exercises on

precautions to be taken while working. This is the amount of time an instructor has before the workers begin their tasks.

C) Effects on learning for temporary workers

Six inexperienced workers (subjects) learned the exercises created by the instructors alone about cutting the stems twice and taking precautions when harvesting mandarin oranges. Approximately 20 minutes was given to the workers to learn the exercises. After using the RAIS system, the subjects actually harvested the mandarin oranges, and their performance was evaluated by two instructors. A ten-point scale was used for the evaluation. Based on the instructor's experience, the grading criteria for this experiment were determined as shown in Table 1. The results of the evaluations by the two instructors are shown in Table 2. After a short learning period, the average evaluation scores of the six subjects increased to 8.2 points. The temporary workers' work level (8.2) was rated 60% higher than the standard level (5). It was verified that they were able to work above the level required of a typical temporary worker.

Table 1. Grading Criteria for Work Level

Score	Proportion of Properly Harvested Fruits
10	100%
9	95-99%
8	90-94%
7	85-89%
6	80-84%
5	75-79%
4	70-74%
3	65-69%
2	60-64%
1	0%-59%

Table 2. Evaluation Results

	Evaluation of instructor 1	Evaluation of instructor 2	Average
Worker 1	7	9	8.0
Worker 2	8	7	7.5
Worker 3	8	8	8.0
Worker 4	10	8	9.0
Worker 5	9	10	9.5
Worker 6	9	5	7.0
Average	8.5	7.8	8.2

D) Questionnaire to the instructors after evaluating the work of the temporary workers

A questionnaire was sent to the two instructors after the subjects' work was evaluated. The questionnaire was designed to assess what subjects were not learning and what they would like to add to the exercises. The following replies indicated what the subjects were not learning.

- *No exercises to improve work efficiency were included.*
- *The mandarin orange was often scratched by the tip of the scissors.*

The following replies indicated what they would like to add to the exercises.

- *The position of the basket*
- *The number of oranges that can be placed in one hand*
- *The number of oranges to put in the container*
- *Dirty oranges that can be thrown away*
- *How to use the scissors*

The basket position in which the cut oranges are temporarily placed is related to work efficiency. The number of oranges that can be placed on one hand is related to work efficiency, too. Temporary workers should cut several oranges and place them in the basket at one time. When the basket is full, the oranges are transferred to a container, which is then loaded onto a truck for transport. Workers fill only about 70% of the container to make it easier to carry the container and to prevent damage to the oranges near the bottom of the container. Dirty oranges that can be thrown away refers to oranges that are too damaged to be sold. How to use the scissors is related to damage prevention of the oranges. After the questionnaire, we interviewed the instructors, and they said that they had an idea of what kind of exercises they wanted to add, and that they could create the exercises by themselves.

10. DISCUSSION

From the results of the experiment in the mandarin orange harvesting operation, it was confirmed that the library function of the Rapid Agri-InfoScience (RAIS) learning support system can be used by the instructor alone to create exercises in a short time before the operation begins and that the quality of the inexperienced workers' work improved by solving the exercises created by the instructor. Because the quality of work done by inexperienced temporary workers improved after only a short period of learning, it can be inferred that the instructors were able to create effective exercises by themselves. In addition, questionnaires and interviews with the instructors suggest that it is possible for instructors to create additional exercises by themselves for any content that the workers did not learn sufficiently or for any content that was not originally included in the exercises. We believe that these results verified the effectiveness of the RAIS model and the RAIS system. The RAIS system, which focuses on creating exercises using images, is effective in solving communication issues, such as language barriers when accepting temporary workers with different native languages [11]. Further verification is necessary for this aspect in the future.

Future research is necessary to verify whether or not the RAIS model and the RAIS system are equally effective for inexperienced instructors in harvesting mandarin oranges. It is also necessary to verify the effectiveness of the RAIS system with respect to crop diversity and work diversity. In other words, it is necessary to verify the effectiveness of the RAIS system in harvesting crops other than mandarin oranges as well as in operations other than harvesting.

11. CONCLUSION

Agriculture has off-seasons and busy seasons. It is common to use temporary workers during the busy season. To ensure that the work is done smoothly and at a consistent level in a limited amount of time, it is desirable to provide guidance on a case-by-case basis.

We proposed the Rapid Agri-InfoScience (RAIS) learning model that is suited to the situation of teaching temporary workers and built the Rapid Agri-InfoScience (RAIS) learning support system. We conducted an experiment at an actual production site and verified that the exercises can be created by the instructors themselves and that the quality of the temporary workers' work can be improved by solving the exercises using the RAIS system. Before doing these exercises, the temporary workers' work level was below the basic level. After using the RAIS system, the temporary workers' work level was rated 60% higher than the basic level.

Acknowledgement

This research was conducted in collaboration with the Keio Research Institute at SFC (Shonan Fujisawa Campus), Keio University through the "AI System Demonstration Project (2012-2014)" and the "Agricultural IT Intellectual Property Utilization Demonstration Project (2015)" subsidized by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan. We would like to express our deep appreciation to the MAFF, the instructors and members of Japan Agriculture (JA) Fukuoka Yame, Kagawa Prefectural Agricultural Experiment Station Fuchu Fruit Research Institute, JA Kagawa and their members, and everyone else involved for their assistance.

REFERENCES

[1] Shinjo, A., IT to Jukurennouka no Waza de Kasegu AI Nougyou [AI Agriculture to Earn Money with IT and Skilled Farmers' Techniques], Tokyo, Nikkei BP, 2017
[2] Kikusawa, M., & Yamakawa, O. E-Learning - Nougyousya Kyouiku he no Kanousei [E-Learning—Does it Work for Farmers' Education?], Agricultural Information Research 2003, 12(4), 347-350, DOI: 10.3173/air.12.347
[3] Ministry of Agriculture, Forestry and Fisheries, 2020 Nourin Gyou Sensasu [2020 Census of Agriculture and Forestry Report], <https://www.maff.go.jp/j/tokei/census/afc/2020/index.html>, see June 13, 2022
[4] Shinjo, A. "Nougyou Jouhougaku [Agricultural Informatics]," Jouhou Shori (Information Processing) 2010, 51(6), 635-641
[5] Shinjo, A., & Kudo, M. Nougyou Bunya ni Okeru IT Katsuyou: Kou Huka Kachi Ka ni Tsunagaru Torikumi [The Practical Use of IT in Agriculture: The Movement into High-value-added Crops and Integrated Solutions], The Journal of the Institute of Electronics, Information and Communication Engineers 2013, 96 (4), 280-285
[6] Yamamoto, J., Nousagyou ni Okeru Chishiki, Ginou no Tokushitsu to Keisyou Houhou [Characteristics of knowledge and skills in agricultural work and how to transmit them], *Nougyou kikai gakkaishi* 2011, 73(5), 276-280, DOI: 10.11357/jsam.73.276
[7] Matsumoto, Y., Soshiki to Ginou [Organization and Skills], Tokyo, Hakuto Shobo, 2003
[8] Nakayama, Y., Chishiki Keisyou no Shikumi Zukuri [Methods for Knowledge Transfer], Journal of Japanese Society for Artificial Intelligence 2007, 22(4), 467-471, https://doi.org/10.11517/jjsai.22.4_467
[9] Arai, G., & Shirakawa, K. Densho no Tame no Ginou Meikakuka Tetsuzuki ni Tsuite: Kison Ginou Bunseki Shuhou no Ketsuraku Shiten Kara no Kentou [The Study on Objectivity of the SKILL: The Point of View from the Systematized Technique of the Digitization of the SKILL], Bulletin of Japan Society for the Study of Vocational and Technical Education 2005, 35(2), 1-8, https://doi.org/10.24485/jssvte.35.2_1
[10] Shinjo, A., Kusui, D., Kudo, M., Ono, Y., Numano, N., Kamiya, T., & Shimazu, H. AI (Agri-Informatics) ni Motozuku Gakushuu Shien Shisutemu no Kenkyuu Kaihatsu [Development of Learning Support System for Agriculture Based on Agri-Informatics], Journal of Artificial Intelligence 2015, 30(2), 174-181, DOI: 10.11517/jjsai.30.2_174
[11] Alanis, V.M., Recker, W., Ospina, P.A., Heuwieser. W., & Virkler. PD. Dairy farm worker milking equipment training with an E-learning system, Animal Nutrition and Farm Systems Short Communication Short Communication, 2022, 3(5), 322-327, https://doi.org/10.3168/jdsc.2022-0217